6-1977

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DAE-CARD Sector Analysis Series: No. 5
June 1977

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This work was completed under
Contract AID/CM/SA-C-73-19 and
Grant AID/CSD-2824

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TABLE OF CONTENTS

I. INTRODUCTION

This report presents results of a study directed toward specification of relationships which determine some important variables in the market for Thai kenaf and which provide empirical estimates of parameters in these relationships. The work has been undertaken in persuit of two general sets of objectives.

First, the research forms part of a larger project in which a comprehensive model is being constructed to represent production, consumption, price determination, and interregional trade and competition for major commodities within Thailand's agricultural economy. The project is being conducted within the Division of Agricultural Economics, Ministry of Agriculture and Cooperatives (DAE), and staff from several of the branches of DAE are participating. The present effort to construct a statistical model of demand and price determination for kenaf is one of several commodity market studies now being conducted under this project.[1]

Second, it is also intended that this work shall form part of the regular work program of the Demand Analysis Sub-Branch of DAE's Marketing Branch. Here there are two sub-objectives. One is to develop analytical structures and results which may be used independently for short-term demand and price forecasting. Although forecasts would rarely be based solely on results from a formal model, such models can provide valuable inputs into the forecasting process.

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[1]The authors wish to express appreciation to Manit Kittiphanichyakul for his valuable assistance in data assembly and model specification.

In addition, it is envisioned that the statistical commodity market models may form the nucleus of studies in the Demand Analysis Sub-Branch designed to analyze certain kinds of policy issues related to individual commodity markets. Such efforts usually have a very specific focus, and no one model will serve for all purposes. However, we believe that models of the type described herein can provide an "advanced starting point" in many cases.

In the sections which follow we first discuss the conditions under which kenaf production takes place and describe the marketing process and its results. Both the present and the recent past are considered. The statistical model is intended to be an abstract representation of the processes which do, in fact, determine market outcomes. Although such models can never encompass all features of reality, the goal is to capture the essentials. This description, then, forms the background for discussing model specification.

The next section contains a discussion of the structure of the model and the logic underlying it. Some of the more important problems with historical data are then considered, followed by presentation of the statistical results. The uses of these results are then discussed. We conclude with an overall evaluation of the precision and reliability of the estimates, some suggestions for further work, and a summary.

II. CHARACTERISTICS OF THAILAND'S KENAF ECONOMY

Production

Although not a dominant crop in Thailand's agriculture, kenaf is nevertheless important. Among the upland crops the average area planted in B.E. 2513/14-2515/16[2] ranked third behind maize and rubber. (1) In contrast to rice and some other food crops, nearly all of the crop is sold by farmers and it represents an important source of cash income. The reported average yearly wholesale value of the crop over B.E. 2513/14-2515/16 was 1,363 million Baht [2].[3]

The above comments apply with greater force to the Northeast region of Thailand where most of the country's production is concentrated. In B.E. 2503-2510, about 98 percent of the country's planted area was in the 15 northeast changwads where it is widely grown in small holdings [1]. Though farms in this region average slightly larger than in other parts of Thailand, farm incomes generally are lower. Receipts from kenaf sales are important to the livelihood of large numbers of the rural population.

Reported area, yield, and production figures for Thai kenaf show a major expansion in area and production over B.E. 2503-2509. Changes in yield have been irregular, and no clear trend is evident (See Table 1). In recent years production has fluctuated greatly and the tendency toward further expansion is less apparent.

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[2]Year designations are given according to the Buddhist calendar. Years of the Christian era are found by subtracting 543.

[3]Adjustments have been made to the reported production data. These are discussed in detail in a later section.

Table 1. Kenaf area, yield, and production in Thailand, 2503-2515

Year	Area	Production	Yield	Value of production
	(1,000 rai)	(1,000 tons)	(kg/rai)	(million Baht)
2503	877	181.3	208.4	547.7
2504	1,190	239.3	201.8	854.3
2505	712	134.4	192.0	314.5
2506	957	211.7	222.9	577.9
2507	1,365	303.1	225.2	863.8
2508	2,401	529.1	227.0	1,597.9
2509	3,314	662.4	213.0	2,185.9
2510	2,177	421.8	197.0	835.2
2511	1,585	316.0	204.0	764.7
2512	2,358	373.4	166.7	993.2
2513	2,631	380.9	156.4	1,070.3
2514	2,891	419.1	145.0	1,114.8
2515	2,951	427.9	145.0	1,904.2

SOURCE: [2].

Kenaf production in Thailand is a low technology process in which land services and farm family labor dominate the input mix.[4] The crop is grown primarily in the Northeast on soils having low fertility. Soil preparation is done mostly with animal power, usually after the first spring rains. Seeds are planted principally by broadcasting or in hills, and use of chemical fertilizers is uncommon. Typically, farms plant seed from their own crop of the preceeding year. Hand weeding and thinning are recommended but not always carried out. Harvesting may begin at about the time the plants flower or even before. The stalks are either cut with a hand knife or pulled from the ground, and then shocked to permit drying and removal of leaves. They are later transported to retting sites

[4] The brief description of kenaf production practices which follows draws heavily upon Sholton [3].

which may be wherever water is available. Retting decomposes the outer vegetative matter leaving the fiber open for stripping. The farmer then washes and dries the fiber and packs it into field bales for transport.

Kenaf Utilization

Most of Thailand's kenaf production is either processed in domestic mills or exported as baled kenaf. No reliable estimates of local consumption in villages are available, but the volume moving into such outlets is generally thought to be very small. Table 2 shows reported export and mill consumption for B.E. 2505 to 2515.

Table 2. Mill consumption and exports of Thai kenaf, 2505-2515

Year	Mill consumption	Export[b] Quantity	Export[b] Value
	(1,000 tons)[a]	(1,000 tons)	(1,000 Baht)
2505	21.9	236.7	575,304
2506	40.5	124.9	355,868
2507	51.1	161.8	494.419
2508	55.7	316.8	1,101,802
2509	69.2	473.0	1,613,071
2510	71.0	316.8	865,196
2511	64.9	289.3	673,744
2512	64.0	254.3	775,285
2513	75.1	253.9	708,857
2514	105.7	268.0	924,109
2515	102.6	252.2	1,076,504

[a]Totals for marketing year beginning September of year shown.

[b]Calendar year totals.

SOURCE: Mill consumption estimates from original data collected by the Bank of Thailand; exports from [2].

Mill consumption in Thailand has tended to grow more rapidly than exports. Expanding domestic milling capacity has been a prominent feature on the domestic market. Although precise figures on capacity over time are not available, it is known that the number of factories has increased from 3 in B.E. 2505 to 10 in B.E. 2515. The principal products manufactured by domestic mills are gunnybags for grain and other agricultural products, and rope.

Exports of baled kenaf have averaged 264,000 tons per year with an f.o.b. value of 832 million Baht over the period B.E. 2511-2515. Kenaf has been the fifth largest foreign exchange earner among Thailand's agricultural exports. Historically, Thailand's kenaf export business has been in the hands of private traders and there has been little government involvement except for normal reporting requirements.

The fortunes of the export trade in kenaf are regarded as being closely related to the market for jute. While kenaf apparently is not a close technical substitute for superior quality jute, it does compete closely with the lower grades. In addition, world production of jute far exceeds that of kenaf. Bandladesh historically has been the world's dominant supplier of raw jute, though production variability has been substantial in recent years.

Besides supply variability, there have been at least two other prominent factors affecting world markets for jute and kenaf during recent years.[5] One has been the introduction and adoption of low-cost synthetic

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[5] See Grilli and Morrison [5] for a comprehensive discussion of the impact of competing synthetics and other factors likely to affect future markets for jute and kenaf. The above discussion is based largely on their report.

fibers which can be used to make products traditionally made from jute and kenaf. Polypropylene cloth bagging for agricultural products and fertilizer perhaps have offered the most direct competition to kenaf, and synthetic carpet backing has make inroads into a major traditional market for jute. Because of recent higher prices for petroleum-based feedstocks, the downward trend in synthetic prices may be arrested, but synthetic fibers seem certain to offer continued strong competition to jute and kenaf.

A second factor that has tended to limit expansion of kenaf demand is the shift toward bulk handling of agricultural products in the economically developed countries and accompanying reductions in demand for bagging made from jute and kenaf. This trend appears to be less pronounced in the developing countries. Recent expansion in the number of Thailand's gunnybag factories would seem to be a case in point.

Kenaf Market Channels[6]

Internal market flows vary from year to year, but it has been estimated that about half of farm sales normally go to local baling plants, 30 percent is sold to village merchants, and 20 percent to district and provincial buyers. Most of the sales to village merchants are resold to local balers. After baling, the kenaf moves to exporters and domestic gunnybag factories.

All exporting is from Bangkok. Sales are either to foreign buyers with local offices, to foreign brokers, or to foreign middlemen and direct consumers. Kenaf for export is most commonly purchased from Bangkok traders but also from provincial traders and from farmers through upcountry baling plants owned by exporters and through exporters' agents.

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[6] The following discussion is based on Sholton [8, 5D-53].

III. A MODEL OF THE THAI KENAF MARKET

General Structure

The objective of the modeling process is to produce a structure, quantitative in character, which may be regarded as an approximate analog to the system which determines the values of variables in the kenaf market. The main variables whose behavior is to be modeled are yearly quantity of kenaf consumed by domestic mills, yearly quantity exported, quantity held as year-end stocks, yearly average domestic price of Thai kenaf, and average foreign price of Thai kenaf.

The historical operation of the market suggests that the processes that determine these variables are interdependent. Both domestic consumption and exports constitute sizeable fractions of total demand in recent years, and fragmentary evidence suggests that year-end stock holdings have also been significant in some years. These demands are clearly competitive. They must be reconciled in a setting where the available domestic supply is essentially fixed from one harvest period to the next. Economic theory, common business practice, and empirical evidence from numerous other studies of commodity markets suggest that each of them may vary with the level of domestic price, among other things. Under these conditions, competitive market theory suggests not only that price influences demand but that price is determined by the condition that the various demands (including ending stocks) equal total supply (including beginning stocks). In such a setting, price and the various quantities demanded are jointly dependent.

The importance of the foreign market for Thai kenaf and the absence of major export restrictions suggest that market conditions abroad also may impact heavily on the domestic market. However, in this case we would expect the effects of variations in Thai kenaf exports on world market conditions to be less pronounced because of the dominant position of competing foreign suppliers.

The general form of the kenaf market model is that of a set of stochastic simultaneous equations. The unknown parameters in each are estimated by standard statistical techniques. Each of the equations is intended to model one of the component forces at work in the kenaf market, at least approximately. Most of the equations are said to be stochastic in that we do not expect the observed data for every year to satisfy the equations exactly. The failure of data to satisfy equations exactly is accomodated by introducing an additive error term, and such errors are regarded as random variables. There are several possible interpretations of these error terms, and we mention only a few. Because the equations are regarded as approximations, we may regard the errors as reflecting the effects of omitted variables, improper functional form, measurement errors, etc. We may also choose to regard them as reflections of the fact that human behavior (which is what we are modeling) is never fully systematic. But regardless of the interpretation, their use provides a bridge over the difficulty that fully deterministic models which reproduce and predict human behavior perfectly cannot be constructed except in the most trivial cases. Fortunately, models which approximate behavior can be constructed, and that is our goal.

In the discussion which follows we describe the component equations in the kenaf model. Error terms are omitted, though they will be discussed in the section where empirical estimates are presented. For the present, we seek only to present and explain the relationships posited among the observed variables. The formulation, or specification, presented here is a description of the form finally adopted. In some cases estimation was attempted with alternative specifications representing some variation on the theme described here. Some of the more important or interesting variations will be discussed in the section on empirical results.

Demand for mill consumption

The specification of the mill consumption demand equation is based on the theory of derived demand. In this case, since raw kenaf is being used as an input into a manufacturing process, we think of the demand for the input as being "derived" from the demand for the products which are produced with it. Static demand theory would suggest a relationship between quantity of kenaf demanded, price of kenaf, prices of other inputs used in the manufacturing process, and price of the manufactured product. The equation used in the model related quantity consumed by mills per year (MILL CON) to the yearly average Bangkok wholesale price for Grade A kenaf (BKK WHPR), yearly average Bangkok wholesale price of gunnybags (GUNYBG P) and the number of kenaf processing mills operating in each year (NO.FCTRY). This is shown in Equation 1.

(1) MILL CON = f_1 (BKK WHPR, GUNYBG P, NO. FCTRY)

Mill consumption and the Bangkok price are regarded as jointly endogenous variables. Though the Bangkok price is not the price paid by mills, it is believed that variation in price paid will follow variation in the Bangkok price sufficiently close that the Bangkok price should be a good proxy. Similarly, the gunnybag price is used to measure the level of price for products made from kenaf because gunnybags appear to be the most important product manufactured from kenaf.

A short-run derived demand relationship normally would be influenced by the level of factors which are fixed in the short-run. Within a year, one would expect little variation in the capacity of the milling industry. This can change over a period of years, however, and Thailand's experience seems to reflect this. The number of factories is used as a proxy for the capacity of the domestic milling industry. Because not all factories are of equal capacity, this variable must be regarded as a distinctly second-best alternative. However, it appears to be the best of those available.

Exporters' demand

The modeling of export demand is accomplished with two equations. The first is intended to model purchases of kenaf by exporting firms in Thailand for shipment abroad, and the second models the determination of the export price (actually, the London price of Grade A Thai kenaf). The equation modeling exporting firms' purchasing behavior is not to be interpreted as a relationship expressing the "rest of the world's" excess demand for Thai kenaf. As will be shown shortly, the specification adopted implies that the rest of the world's excess demand for Thai kenaf can be adequately represented by the foreign price, and the level of Thailand's exports over a year has no appreciable effect on the foreign price. In other words, export demand is infinitely elastic at the world price.

The specification of the exporters' demand equation is intended to portray arbitraging behavior. That is, exporting is presumed to be motivated by opportunities to earn profits by purchasing in a lower priced market (the domestic market) and selling in a higher priced market (the foreign market). Alternatively, the process may be conceptualized in terms of derived demand as was the case with mill consumption. The two approaches lead to results which do not differ in their essentials. The equation finally adopted relates yearly exports (EXPORTS) to the average Bangkok wholesale price of grade A kenaf, the yearly average London price of grade A Thai kenaf (LN KF PR), and Thailand kenaf production plus beginning stocks (PRODUCTN + BEG STKS). This is shown in Equation 2.

(2) EXPORTS = f_2 (BKK WHPR, LN KF PR, PRODUCTN + BEG STKS)

The two prices are intended to reflect the incentives for arbitrage through exporting. The available supply (production plus beginning stocks) is introduced to reflect the existing limitations to the scale of the arbitraging operation in any year. In this formulation, exports, Bangkok price and London price are treated as endogenous variables, or variables to be explained, and the others are treated as predetermined.

Foreign price predicting equation

This equation is intended to model the determination of the London price of grade A Thai kenaf. Its specification is very similar to what has been called a world demand equation in other agricultural commodity demand studies where recursiveness is apparent in the determination of production, demand, and price.[7] Because the total amount available for distribution over a year is essentially determined at the time of harvest, it is reasonable to think of yearly average price being determined as that value on the market demand curve which will equate total demand to the predetermined total supply. In this study we have specified an equation which related an international price (the London price of grade A Thai kenaf) not to total world supply, but to beginning stocks plus production in Bangladesh (BANG S + P), the country which is the leading producer within the closely competitive jute-kenaf group. This particular component of the world supply appears to have an especially strong influence on international prices. In addition to Bangladesh supply, the equation also includes as explanatory variables the average price of polypropylene cloth in the U.S. (USPPC PR), and the United Nations index of prices of all primary products moving in international trade (PRM XP P). These are shown in Equation 3.

(3) LN KF PR = f_3 (BANG S + P, USPPE PR, PRM XPP)

Polypropylene cloth appears to be one of the most direct substitutes of kenaf in the manufacture of bagging in developed countries. Its price is introduced to represent prices of synthetic synthetic substitutes. The primary product price index may be regarded as indicating price levels of substitutes in a more general sense. Its practical role in the empirical work is to serve as a proxy for the set of factors which resulted in a major world wide inflation of prices of primary products during the early

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[7] See, for example, Meinken [7].

1970's. It seems fair to say that the true causes of this inflation are not yet fully understood. Nevertheless, it has been very real, and the use of the index appears to be a reasonable way to capture its effect on the Thai kenaf economy.

In Equation 3 all variables are regarded as predetermined except the London price of grade A Thai kenaf. It is considered to be endogenous.

Demand for ending stocks

The equation which models demand for ending stocks (END STKS) largely reflects speculative behavior. It is defined in terms of Bangkok price of grade A kenaf and Thailand's kenaf supply, Equation 4.

(4) END STKS = f_4 (BKK WHPR, PRODUCTN + BEG STKS)

This may be regarded as a reservation demand on the part of stockholders. It expresses their willingness to sell into consumption channels principally as a function of the rewards from selling; i.e., the price. The equation also includes supply because of the bound it sets on the reservation or speculative process. In this case, ending stocks and the Bangkok price are considered to be endogenous and the supply is taken to be predetermined.

Market-clearing conditions

The last equation in the model, Equation 5, is simply one which requires that the sum of the components of supply equal the sum of the components of demand.

(5) PRODUCTN + BEG STKS = MILL CON + EXPORTS + VIL CONS + END STKS

In addition to variables defined earlier, it contains village consumption (VIL CONS) as a component of total demand. Mill consumption, exports, and ending stocks are treated as endogenous variables while production, beginning stocks, and village consumption are treated as predetermined variables.

Besides expressing an accounting requirement, this equation embodies an important part of the economic logic of the model. On the one hand, it expresses the inescapable requirement that any explanation of the quantity demanded and its component parts must take into account the available supply. On the other hand, the process of reconciling supply with demand is the process which determines price, i.e., price is that value at which total demand can equal total supply.

Kenaf supply

It is apparent that there are many applications in which it would be desirable to take account of supply response concurrently with the modeling of kenaf demand and price determination. More specifically, the relationship between quantity supplied and price is of interest. This has not been done in the present investigation principally because such an effort is not among our present objectives. The most immediate use of the results reported here is expected to be in connection with the national model of Thailand's agriculture now being formulated within DAE. The modeling of kenaf supply response is being accomplished as part of the linear programming model of the agricultural sector.

Furthermore, the nature of the production process is such that we would expect supply in any year to be most closely related to prices observed before that year and not to be contemporaneous prices. Under these conditions, statistical demand analysis may proceed while treating supply as a predetermined variable in the statistical sense without problems of simultaneous equations bias.

IV. SUPPLY AND UTILIZATION DATA

Prior to doing formal statistical analysis it has been necessary to deal with some difficult problems inherent in the available data. One in particular deserves special attention, and the procedures used will be discussed in detail so that the reader may interpret the results in proper perspective.

The problem has to do with reconciling the available production and utilization estimates. Of course, this is a useful accounting check on the consistency of the data. But it is doubly important here because the requirement that supply components equal demand components is a part of the model and is an integral part of the price determination process.

Table 3 shows data on the principal components of kenaf supply and demand as they were initially assembled. Sources are shown as footnotes to the table. Of these data, the village consumption estimates are almost certainly the least reliable. No direct estimates have ever been made. However, general opinion in the trade appears to be that village consumption is a relatively insignificant fraction of total demand, and the series shown makes allowance for them. These estimates appear in Sholton [8, p. 12].

Table 3. Reported kenaf supply and utilization data, 2508/09-2515/16

(1,000 metrictons)

Year	Supply Components: Beginning stocks	Supply Components: Production	Mill consumption	Demand Components: Exports	Demand Components: Village consumption	Ending stocks
2508/09	13.0	529.1	55.7	399.9	6.6	n.a.
2509/10	n.a.	662.4	69.2	478.9	6.8	n.a.
2510/11	n.a.	421.8	71.0	272.6	7.0	n.a.
2511/12	n.a.	316.0	64.9	273.4	7.2	20.0
2512/13	20.0	373.4	64.0	279.4	7.4	n.a.
2513/14	n.a.	380.9	75.1	229.3	7.6	3.0.
2514/15	3.0	419.1	105.7	258.7	7.8	2.8.
2515/16	2.8	419.6[a]	102.6	266.8	8.0	n.a.

[a]The figure shown is the preliminary production estimate which was available at the time the study was begun. It has since been revised to 427.9 in [2]. Results reported in subsequent sections are based on a 1972/73 production estimate of 419.6 thousand tons. The equationa have since been reestimated using the revised 1972/73 production estimate, and all differences are minor.

n.a. = not available.

SOURCE: The four stock figures shown and mill consumption are from the Bank of Thailand. The mill consumption estimates are are for years beginning in September. Village consumption estimates are from [8, p. 12]. Production estimates are from [2]. Basic data for export estimates are in [3]. The estimates are September - August total exports of kenaf, kenaf tow, kenaf cutting, and kenaf waste.

With proper, inclusive definitions of the components of supply and utilization, then it is clear that the components of supply each year must equal the utilization components. This criterion cannot be applied directly to the data in Table 3 because we do not have estimates for all components in each year. However, similar checks can be applied. First, the sum of 2508/09 beginning stocks, plus 2508/09 through 2511/12 production, minus mill consumption, exports and village consumption for 2508/09 through 2511/12 should approximate 2511/12 ending stocks (or 2512/13 beginning stocks). These calculations are shown below:

2508/09 beginning stocks	13.0
+ production for 2508/09-2511/12	1,929.3
= (total supply, 2508/09-2511/12)	1,942.3
- mill cons; exports, vill. cons. 2508/09-2511/12	1,713.2
= "expected" ending stocks, 2511/12	229.1
- reported ending stocks 2511/12	20.0
= apparent excess supply, 2508/09-2511/12	209.1

The results show that over the 4-year period, initial supply estimates exceed initial utilization estimates by 209.1 thousand tons, or nearly 11 percent of reported production. Clearly, it is not possible to identify precisely the sources of inconsistency. In the case at hand, we have chosen to reconcile the estimates by adjusting production. The mill consumption, stocks, and export data are regarded as being sufficiently reliable to be taken at face value. The village consumption estimates are not, but it seems doubtful that this outlet could account for an additional average utilization of 52,000 tons per year. Such an adjustment would imply that village consumption was nearly as important as mill consumption. This cannot be ruled out a priori, but it would conflict with most opinions on the matter.

Thus, the actual adjustment considered of (1) multiplying each production estimate for 2508/09 through 2511/12 by the following factor:

$$\frac{\text{(2508/09-2511/12 reported production - "excess supply")}}{\text{2508/09-2511/12 reported production}} = \frac{1929.3-209.1}{1929.3}$$

$$= .8916$$

2) Using the adjusted production estimates, estimating 2508/09 ending stocks (= 2509/10 beginning stocks) by subtracting that year's mill consumption, exports and village consumption from the sum of production plus beginning stocks. This process was repeated to estimate, in sequence, beginning stocks for 2510/11 and 2511/12. The results are shown in Table 4.

Table 4. Adjusted kenaf supply and utilization data 2508/09-2515/16

Year	Supply Components: Beginning stocks	Supply Components: Production	Mill consumption	Demand Components: Exports	Demand Components: Village consumption	Ending stock
			(1,000 tons)			
2508/09	13.0	471.8	55.7	399.9	6.6	22.6
2509/10	22.6	590.6	69.2	478.9	6.8	58.3
2510/11	58.3	376.1	71.0	272.6	7.0	83.8
2511/12	83.8	281.7	64.9	273.4	7.2	20.0
2512/13	20.0	335.8	64.0	279.4	7.4	5.0
2513/14	5.0	310.0	75.1	229.3	7.6	3.0
2514/15	3.0	372.0	105.7	258.7	7.8	2.8
2515/16	2.8	419.6	102.6	266.8	8.0	45.0

A similar process was applied to adjust reported 2512/13 and 2513/14 production and to estimate 2513/14 beginning stocks. Here, however, the estimated two-year excess of reported production over estimated utilization was 105.8 thousand tons, or about 14 percent of total production. A proportionate reduction estimates of 319.7 and 326.1 thousand tons, respectively. However, this estimate of 2512/13 production, together with other components of 2512/13 supply and demand shown in Table 3 would have implied a negative carryover stock at the end of the year of 11.1 thousand tons. This, of course, could not have happened.

Monthly utilization figures for Thai kenaf mills show no noticeable tendency to decline seasonally at the end of the marketing year, and this is true of the 2512/13 monthly data. Under these conditions it seems certain that working, or "pipe line" stocks, would have had to be maintained at some positive level at the end of the year. In consideration of the amount of adjustment to be made in the two-year total production and the likelihood of some positive stock level at the end of the 2512/13 year, we used 5,000 tons as an estimate of 2512/13 ending stocks. Having done so, we estimated production for 2512/13 and 2513/14 as residual items using the other supply and utilization figure in Table 3. In this manner, total production for the two years was reduced by 108.5 thousand tons, but the two estimates were not reduced by the same percentage.

In a similar manner, 2514/15 production was adjusted so that the sum of supply components equals the sum of the demand components. In this case, the production estimate was reduced by about 12 percent to arrive at the result shown in Table 4.

Reported production for 2515/16 was used directly, although as noted in a footnote to Table 3, this estimate has since been revised upward by about 2 percent. The ending stock figure shown for 2515/16 was determined as a residual.

The data shown in Table 4 are those which were used for estimation. Certainly there is arbitrariness in the results, and better starting data would have been desirable. Too, the length of the resulting time series is minimal for this type of analysis, but the lack of earlier estimates of any kind on some key variables precluded estension of the data set. On the other hand, evidence available suggests that as recently as 1960 the volume of production was so small that the value of information on market activity in earlier years may not have been great.

V. STATISTICAL RESULTS

In this section we present the parameter estimates for each of the four nonidentity equations in the model together with related information about the numerical results. A few comments will apply to each of the equations and they will be considered before the estimates are presented.

The complete sets of endogenous and predetermined variables appearing in the model and their units of measurement are given in Table 5. The dimensions (or units of measurement) of all parameter estimates are defined in terms of the dimensions of the variables as shown in Table 5. All parameter estimates are defined in terms of the dimensions of the variables as shown in Table 5.

Table 5. Variables appearing in the kenaf model

Endogenous variables	Predetermined variables
1. Mill consumption (1,000	1. Wholesale gunnybag price (฿/100)
2. Exports (1,000 tons)	2. Number of kenaf mills (mills)
3. Ending stocks (1,000 tons)	3. Bangladesh jute stocks + production (1,000 tons)
4. Bangkok wholesale kenaf price (B/kg)	4. U.S. polypropylene cloth price (U.S. ¢/sq. yd.)
5. London kenaf price (B/kg)	5. U.N. primary product export price index (1963=100)
	6. Village consumption (1,000 tons
	7. Thailand kenaf production (1,000 tons)
	8. Thailand beginning stocks (1,000 tons)

Among the four equations to be estimated, one (the foreign price equation) contains only one endogenous variable. In that case, the single endogenous variable, London kenaf price, is regressed on its explanatory variables; Bangladesh jute supply, polypropylene price, and the primary product export price index using ordinary least squares (OLS). These OLS estimates are used in the model.

The other three equations each contain more than one endogenous variable, and two-stage least squares (TSLS) is used as the estimation procedure. The TSLS procedure requires the user to first normalize the coefficient of one endogenous variable in each equation by setting it equal to one (1.0). Under ideal conditions, the user would then proceed to the first stage in which each remaining endogenous variable in the equation is regressed on all predetermined variables in the model using ordinary least squares.

In this study, as in many others, a modification has been necessary because the number of predetermined variables is large relative to the number of observations in the available data set. At a minimum, it is necessary to have one more observation than the number of first stage regressors (assuming that a constant term is included), and if only this minimum condition is met the resulting TSLS estimates are identical to OLS estimates. Thus, as a practical matter, if TSLS is to have any value in remedying the problems inherent in OLS estimates, it is necssary that the first stage regressions be estimated with at least a few degrees of freedom.

Econometric literature poses many solutions to this problem which preserves the asymptotic properties of the TSLS estimates. In the present case, the set of first stage regressors used is comprised of the wholesale gunny price, the number of kenaf mills, beginning stocks plus production of Thai kenaf, and the calculated (not actual) values of the London price of Thai kenaf resulting from the OLS estimate of the foam price equation. This latter variable is, of course, a linear combination of three predetermined variables (Bangladesh supply, ploypropylene price, and the primary product export price index). Village consumption is excluded because the data are purely the output of a judgment process, and the series is merely proportional to a linear trend variable. Thai production and beginning stocks are combined because they never appear singly in the model, and, as components of predetermined supply, it can be inferred that their effects on the endogenous variables should not be too dissimilar.

Demand for Mill Consumption

The estimated mill consumption demand relation is given in Equation (6). All coefficients take on the expected signs.

(6)	MIL CON = -84.751	-12.098 BKK WHPR	+ .108 GUNYBG PR	+ 13.763 NO FCTRY
	std. error:[8]	(14.67)	(.082)	(6.18)
	elasticity:[9]	(-.52)	(1.05)	
	$s_{y \cdot x}$ = 12.8 thousand tons[8]			

[8]Standard errors given for the coefficients and $s_{y \cdot x}$ are estimates of the asymptotic standard errors in the case of the TSLS estimates, and estimates of small sample standard errors in the case of OLS estimates. Calculated t-values are given for OLS coefficients, but not for TSLS coefficients since the small sample distriution of the calculated quantities is not known. Similarly, R^2 values are given only for equations estimated by OLS.

[9]In all cases, reported elasticities are calculated using mean values of the variables and the relationship: elasticity = $\frac{\partial q}{\partial p} \cdot \frac{p}{Q}$. Thus, the "own price" elasticity of demand for a downward sloping demand curve will be given as a negative number.

The precision of the parameter estimates is not as great as would be desired, especially for the coefficient of Bangkok price where the standard error of the coefficient is larger than the estimated coefficient. The standard error estimate, $S_{y \cdot x}$, estimates the variance of the residuals about the regression surface. The estimate, 12.8 tons, is about 17 percent of mean mill consumption, or about 10-12 percent of mill consumption in recent years.

Mill consumption appears to be responsive to the price of kenaf and especially to the gunnybag price. The results suggest that a one percent increase in gunnybag price by itself would increase mill consumption by about 1 percent, while a 1 percent increase in kenaf price would depress consumption by about one-half percent. As mentioned earlier, the number of factories is used as a proxy for the capacity of the milling industry. Although a more appropriate variable would have desirable, the results suggest that the expansion of capacity has been a major factor in explaining domestic demand for kenaf.

Exporters' Demand

The estimated exporters' demand equation is given in Equation (7). Here again, standard errors are large; only 9-12 percent smaller than the associated coefficients. The standard error of estimate, 33.4 thousand tons, is about 11 percent of mean exports.

(7) EXPORTS = -79.411 + 141.045 (LNKF PR - BKK WHPR) + .466 (BEG STKS + PRODUCTN)

std. error: (129.67) (.378)

elasticity: (2.12) (-1.52)

$S_{y \cdot x}$ = 33.4 thousand tons

Both estimated price elasticities are greater than 1 in absolute value, suggesting that the two prices and their difference are important in determining exports.

Other variations on the specification shown in equation 7 were tried and at least two are worth mentioning. First, the equation was estimated using London kenaf price and Bangkok price as separate regressors. Each coefficient had the expected sign, and the difference between their absolute values was not statistically significant. Because of this (together with the logic of using the price difference, the reduction in multicollinearity problems, and the savings in "scarce" degrees of freedom), the price difference formulation was adopted. Secondly, the equation was fitted with omission of the beginning stock plus production variable. The estimated TSLS coefficient of London price minus Bangkok price was 290.5 and its standard error was 52.1. However, the standard error of estimate for the equation was 37.7 thousand tons compared to 33.4 thousand tons for Equation 7 above. Equation 7 (was accepted because of its greater explanatory power and because of the logical arguments for the inclusion of the supply variable.

Foreign Price Predicting Equation

The final version of the foreign price predicting equation is given as Equation (8). Standard errors of coefficients are substantially lower relative to coefficient values, and the standard error of estimate, .33 B/Kg, is about 7 percent of the mean London kenaf price.

(8) LN KF PR = 7.075 −.00494 BANG \$-P + .069 USPPC PR + .027 PRM XP P

std. error:	.0011	.033	.0064
t-value	(−4.36)	(2.07)	(4.20)
elasticity:	(−1.42	(.22)	(.67)

$S_{y \cdot x}$ = .33 B/Kg $\quad R^2$ = .90

Both prices of synthetics and of all primary export products are seen to have significant effects on London kenaf prices. During the period under study (B.E. 2508/09-2515/16) polypropylene cloth prices dropped about 10 cents per pound. The results shown in Equation 7 suggest that this, by itself, would have accounted for about a 70 satang per kilogram decline in London Kenaf prices. Recent increases in all primary product export prices have been strongly associated with rising kenaf prices.

Other supply variables were tried in addition to or instead of the Bangladesh supply. Among them were world jute and kenaf production, Indian jute production, and Thai kenaf production. However, the Bangladesh supply variable provided the most satisfactory results. Further analysis of the relation between world supply factors and the foreign price of Thai kenaf would be desirable, but the length of available data series severely limits the possibilities.

Demand for Ending Stocks

Results for the last equation, demand for ending stocks, are given as Equation (9). As shown earlier the data on stocks have been estimated by an indirect process, and it is apparent that they may well contain

(9) END STKS = 32.530 - 17.552 BKK WHPR + .130 (BEG STKS + PRODUCTN)

std. error: (11.74) (.103)

elasticity: (-1.90)

$S_{y \cdot x}$ = 23.5 thousand tons

large measurement errors. The relatively large standard error of estimate, 23.5 thousand tons or about 78 percent of mean ending stocks, is perhaps in part a reflection of these errors. Nevertheless, coefficients show moderate statistical significance and they do not appear unreasonable from the point of view of economic logic. The evidence found in Equation 9 suggests that stock holding is especially sensitive to prices of kenaf. In fact, of the three components of kenaf demand, demand for ending stocks shows the greatest elasticity with respect to kenaf price, followed by export demand and then demand for mill consumption.

The Kenaf Market Model as a Set of Simultaneous Equations

Before discussing applications of the results, it is well to collect them in a form which will be more useful and which leads to an additional test of "goodness of fit" for the model.

Our model takes the form of a set of five simultaneous linear equations which have as their solution the values of the five contemporaneous endogenous variables. This set of equations can be written as a single matrix equation. To do so we use the following definitions: y = a5 x 1 vector of observations on the current endogenous variables; x_t is a 9 x 1 vector of observations on the predetermined variables associated with period t; B is a 5 x 5 matrix of extimated coefficients of the endogenous variables; G is a 5 x 9 matrix of estimated coefficients of the predetermined variables; and u_t is a vector of residuals from the equations. In abbreviated form, the model can be written as in Equation (10). If we ignore the residuals (or set them

$$B\,y_t = G\,x_t + U_t \tag{10}$$

at their zero expected values), we may substitute the estimated coefficients just presented into B and G, and the model variables in x_t and y_t to get Equation (11). Using B and G matrices shown in Equation 11,

$$\begin{pmatrix} 1 & 0 & 0 & 12.098 & 0 \\ 0 & 1 & 0 & 141.045 & -141.045 \\ 0 & 0 & 1 & 17.522 & 0 \\ 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \text{MILL CON}_t \\ \text{EXPORTS}_t \\ \text{END STKS}_t \\ \text{BKK WHPR}_t \\ \text{LN KF PR}_t \end{pmatrix} \tag{11}$$

$$= \begin{pmatrix} -84.751 & .108 & 13.763 & 0 & 0 & 0 & 0 & 0 & 0 \\ -79.411 & 0 & 0 & 0 & 0 & 0 & 0 & .466 & .466 \\ 32.530 & 0 & 0 & 0 & 0 & 0 & 0 & .130 & .130 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 1 \\ 7.075 & 0 & 0 & -.0049 & .069 & .027 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} 1 \\ \text{GUNYBG P}_t \\ \text{NO. FCTRY}_t \\ \text{BANG S} + \text{P}_t \\ \text{USPC PR}_t \\ \text{PRM XPP}_t \\ \text{VIL CONS}_t \\ \text{PRODUCTN}_t \\ \text{BEG STKS}_t \end{pmatrix}$$

we can multiply both sides of the equation by B^{-1}. This gives a new matrix equation known as the reduced form. It provides a solution for each endogenous variable solely in terms of the predetermined variables. This solution is shown in abbreviated form in Equation (12) and in expanded form in Equation (13).

(12) $y_t = B^{-1} G x_t - \pi x_t$

(13)
$$\begin{pmatrix} \text{MILLCON}_t \\ \text{EXPORTS}_t \\ \text{END STKS}_t \\ \text{BKK WHPR}_t \\ \text{LNKF PR}_t \end{pmatrix} = \begin{pmatrix} -146.146 & .100 & 12.788 & .049 & -.692 & -.270 & -.071 & .028 & .028 \\ 202.687 & -.089 & -11.373 & -.121 & 1.695 & .662 & -.826 & .800 & .800 \\ -56.407 & .011 & -1.415 & -.072 & -1.003 & -.392 & -.103 & .172 & .172 \\ 5.075 & .001 & .081 & -.004 & .057 & -.022 & .006 & -.002 & -.002 \\ 7.075 & 0 & 0 & -.005 & .069 & -.027 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} 1 \\ \text{GUNYBG P}_t \\ \text{NO. FCTRY}_T \\ \text{BANG S} \neq \text{P} \\ \text{USPPC PR}_t \\ \text{PRMXPP}_t \\ \text{VIL CONS}_t \\ \text{PRODUCTN}_t \\ \text{BEG STKS}_t \end{pmatrix}$$

Equation 13 was used to determine a simultaneous solution for the endogenous variables in the model for each year in the period 2508/09 -2515/16 by substituting the observed values of the predetermined variables for each year. In the case of beginning stocks, however, we recognize that this is actually a lagged endogenous variable; i.e., it is the ending stock variable of the prior year. Thus, in finding simultaneous solutions for all years after the first, the calculated ending stock value for the year before is used as the observation on beginning stocks rather than the observed value. The observed value is used in calculating the 2508/09 solution. The results are shown in Table 6.

Table 6. Calculated and observed values of endogenous variables in the Thai kenaf market model

Year	Type[a]	MILL CON (1,000/tons)	EXPORTS (1,000/tons)	END STKS (1,000/tons)	BKK WHPR (B/Kg.)	LN KF PR (B/Kg.)
2508/09	c	57.0	381.4	39.8	3.18	4.85
	o	55.7	399.9	22.6	3.54	5.24
2909/10	c	72.1	485.4	66.1	2.76	4.68
	o	69.2	478.9	58.3	2.34	4.19
2510/11	c	58.1	319.8	56.7	1.90	3.27
	o	78.1	272.6	83.8	1.97	3.35
2511/12	c	69.6	243.4	18.2	3.32	4.49
	o	64.9	273.4	20.0	3.29	4.38
2512/13	c	76.1	241.7	28.8	2.84	3.94
	o	64.0	279.4	5.0	2.78	3.91
2513/14	c	78.3	236.3	16.6	3.42	4.54
	o	75.1	229.3	3.0	3.43	4.67
2514/15	c	94.5	280.4	5.9	4.40	5.66
	o	105.7	258.7	2.8	4.61	5.75
2515/16	c	103.5	299.6	14.4	4.19	5.47
	o	102.6	266.8	45.0	4.11	5.40
Theil's Statistic U		0.049	0.044	0.240	0.031	0.025

[a]Values in rows labeled c are calculated with Equation 13; those in rows labeled o are observed values.

The "U-statistic" shown at the bottom is a measure of how well the calculated values agree with the actual or observed values. A value of zero indicates perfect correspondence. The calculated London price series is seen to be most nearly in agreement with actual data, while the ending stocks estimates, not surprisingly, deviate furthest from the original data. In general, however, the results seem to suggest a satisfactory fit.

VI. APPLICATIONS

Three class of applications of the results from the kenaf model will be discussed. The first will be only mentioned and not developed in detail. That is the use of the estimated demand structures in the sector analysis model of Thailand's agricultural economy. In this case, the mill consumption, export, and ending stock demand equations for the country as a whole will form the basis for specifying demand relationships for individual regions within Thailand. These, together with the linear programming model of production and transportation will be used to estimate simultaneously the production, distribution, resource use, price, and consumption outcomes which might result from specific economic policy choices which may be under consideration by the Government of Thailand.

A second class of applications includes forecasting or market outlook work. Successful forecasting of market outcomes is never a mechanistic process, and the use of a formal model is no exception. Certainly the analyst will frequently wish to take into account subjective and objective information which may not be specifically represented in the model.

Nevertheless, the model can be a usefull aid to forecasting. The procedure is much like that used in calculating the values which appear in Table 6. Values of the predetermined variables specific to the forecast period must first be determined. These are then used together with Equation 13 to calculate values of the endogenous variables for the forecase period. Such forecasts are most easily made for one time period into the future. This is because the supply variables change substantially from year to year and it is very difficult to estimate them accurately very far into the future. Too, one would strongly suspect that lagged kenaf prices may have important effects on production, and such effects are not included in the present version of the kenaf market model.

A third class of applications may be characterized as impact analyses. To discuss them, we refer again to Equation 13 and particularly to the matrix of numerical coefficients therein. The coefficients of the reduced form provide measures of the direct and indirect effects of changes in the predetermined variables on the endogenous variables. Specifically, the coefficient in row i and column j is an estimate $\partial y_{tt}/\partial x_{jt}$, where y_{it} is the observation in year t on the i-th endogenous variable, and x_{jt} is the t-th observation on the j-th predetermined variable. Thus, for example, the elements in column 4 (reading from top to bottom) suggest that a 1,000 ton increase in Bangladesh jute supply, with all other predetermined variables unchanged, would result in about 50 tons greater mill consumption in Thailand, 120 tons decrease in exports, 70 tons, stock increase, 4 satang decrease in the Bangkok price, and .5 satang decrease in the London price of Thai kenaf. Subject to the usual qualifications related to the accuracy of the estimates, and the appropriateness of the model specification, such measures are useful in that they summarize the effects of an exogenous shock on a variable which is part of an interdependent system such as a commodity market. We will not discuss all the implications of the reduced form coefficients. However, one feature is worth noting. A comparison of the first two coefficients in each column suggests that exports are especially sensitive to changes in nearly all of the predetermined variables. Domestic supply variables, and all variables related to the foreign market, tend to have greater impacts on exports than on mill consumption. Effects on ending stocks tend to be large also, but these become beginning stocks in the following year. The coefficients in the last column suggest that the ultimate quantity adjustment would be primarily born by exports. Here too, however, inclusion of supply analysis would enhance the usefulness of the results.

VII. SUMMARY AND IMPLICATIONS FOR FURTHER RESEARCH

A five-equation statistical model of Thailand's kenaf market was estimated and its properties investigated. The specification was intended to reflect the central features of the market it has been operating since B.E. 2508. The equations model the determination of three components of annual demand for Thailand's kenaf, the domestic price, and the foreign price. In general, the specification reflects relatively conventional market theory. Although the precision of individual coefficient estimates is not as good as could be desired, the model as a whole seems to explain the behavior of the main endogenous variables reasonably well, and the results are judged to be satisfactory.

Several potential improvements and extensions can be readily cited, but their implementation will not necessarily be easy. Certainly the availability of more extensive and reliable data is a pressing need. As it becomes available over time, the existing data series should be updated and possibly revised, and updating of the parameter estimates would be desirable as well.

Extensions of the model in two directions also look promising. The desirability of including supply relationships has been noted earlier. In addition, the assumption that prices of processed kenaf products may be treated as exogenous has been adopted more as an expedient than as a result of careful analysis. An investigation into the demand for these products could be beneficial, and a concurrent modeling of the markets for kenaf and kenaf products could provide useful information about the outlook for the domestic industry. However, these matters have been beyond the scope of the present study.

REFERENCES

1. Division of Agricultural Economics, Office of the Under-Secretary of State, Ministry of Agriculture, Agricultural Statistics of Thailand, 1967, 1970. (English)

2. Division of Agricultural Economics, Office of the Under-Secretary of State, Ministry of Agriculture Agriculture and Cooperatives, Agricultural Statistics of Thailand, Crop Year 1972/73, 1974. (English)

3. Department of Customs, Ministry of Finance, Foreign Trade Statistics of Thailand, monthly issues for 2508-2516. (English)

4. Food and Agriculture Organization of the United Nations, Intergovernmental Group on Jute, Kenaf and Allied Fibers, Reports of the First Trhough Eighth Sessions, Rome.

5. Grilli, Enzo and Ralth Morrison, Jute and the Synthetics, International Bank for Reconstruction and Development, Bank Staff Working Paper No. 171, January 1974.

6. Indian Jute Mills Association, Annual Summary of Jute and Gunny Statistics, various issues.

7. Mienken, Kenneth W., The Demand and Price Structure for Wheat, U.S. Department of Agriculture Technical Bulletin 1136, November 1955.

8. Sholton, Erwin J., A Kenaf and Jute Development Program for Thailand A report prepared for the National Economic Development Board, Royal Thai Government, in cooperation with the U.S. Operations Mission to Thailand, Agency for International Development, Bangkok, Thailand, Under Contract AID 493-052-T by Agri-Business Consultants, January 1973.

9. United Nations, Department of Economic and Social Affairs, Monthly Bulletin of Statistics, March, June, September, and December issues of various years.

APPENDIX

The purpose of this appendix is to present additional statistical data which were used in fitting the equations of the kenaf model. Others have been presented earlier, together with their sources and a discussion of adjustments which were made to the original data. These will not be repeated. The reader is referred to Tables 3 and 4 in the text and the associated discussion for this information.

Data in columns 1-4 of Appendix Table I were tabulated from original data collected by the Bank of Thailand. Some have been published in the Bank of Thailand Bulletin. Each of the price data shown in columns 1-3 are averages of 12 monthly figures over a September-August marketing year. London prices are c.i.f. London. Original data were reported in §/long ton, and they have been converted, to B/Kg. using exchange rates published by the Bank of Thailand.

Bangladesh supply was calculated from [4] and [6]. In general, data were taken from the most recently published of these periodical reports in order to incorporate revisions to estimates. Such revisions are frequently large. U.S. polypropylene cloth prices are from [5] and they are calendar year averages for the second year shown in the split-year designations used in Appendix Table I. Lastly, the primary product exports price data are from [9]. Each annual figure is a simple average of four quarterly indices; the fourth quarter of the first year shown in the split year designation, and the first three quarters of the second year shown.

Appendix Table I. Additional data used in fitting the kenaf model

Year	Bangkok wholesale price, grade A kenaf	London wholesale price, grade A Thai kenaf	Bangkok wholesale price of gunnybags	Number of operating kenaf mills	Bangladesh jute production plus beginning stocks	U.S. poly-propylene cloth price	Primary product export price index
	(฿/Kg.)	(฿/Kg.)	(฿/100 bags)		(1,000 tons)	(U.S.¢/-sq. yd.)	(1963 = 100)
2508/09	3.54	5.24	779.3	7	1,334	22.0	104.8
2509/10	2.34	4.19	743.9	8	1,324	20.0	102.0
2510/11	1.97	3.35	517.7	8	1,542	16.0	99.8
2511/12	3.29	4.38	656.4	9	1,282	14.0	102.8
2512/13	2.78	3.91	662.6	9	1,269	11.0	106.0
2513/14	3.43	4.67	748.3	9	1,289	11.0	113.3
2514/15	4.61	5.75	880.9	10	1,140	12.0	125.3
2515/16	4.11	5.40	940.7	10	1,396	12.5	163.5